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# (54) Plastics bottles & method of reducing gas permeability

(57) The invention provides an injection blow moulded plastics bottle having a label on the outer surface thereof comprising a gas barrier for reducing or preventing the permeation of gasses through that part of the wall of the bottle covered by the label. The invention also provides a method of reducing sorption losses of carbon dioxide from a carbonated drink contained in an injection blow moulded plastics bottle by filling the bottle with carbon dioxide under pressure until th material of the bottle has absorbed some of the carbon dioxide prior to filling the bottle with the carbonated drink. Filling of the bottle with carbon dioxide may be effected during bottle blowing by using carbon dioxide as the blowing medium. Alternatively, the bottle may be filled with carbon dioxide after bottle manufacture but before beverage filling.

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# PLASTICS BOTTLES & METHOD OF REDUCING GAS PERMEABILITY

This invention relates to injection blow moulded plastics bottles and to a method of reducing the gas permeability thereof.

The term "injection blow moulded plastics bottle" as used herein and in the claims hereof means a plastics bottle produced by injection blow moulding or injection stretch blow moulding. The term "bottle" as used herein and in the claims hereof means a bottle, jar or like container.

Injection blow moulded bottles formed from PET (polyethylene terephthalate) are used for containing drinks and foodstuffs such as carbonated drinks, beers, wines, pickles and sauces.

When injection blow moulded PET bottles are used to contain carbonated drinks there is a loss of carbon dioxide from the bottle which limits the shelf life of the product. Normally bottles of carbonated soft drink contain four volumes of carbon dioxide and the normal shelf life criteria is that the bottle should not lose more than 15% volume carbon dioxide in 90 days. Carbon dioxide loss from a carbonated soft drink contained within an injection blow moulded PET bottle occurs by a combination of (a) sorption, i.e. absorption of carbon dioxide into the wall of the bottle, (b) creep, i.e. expansion of the wall of the bottle due to the internal carbon dioxide pressure which increases the head space in the bottle so that carbon dioxide is lost to the head space to re-establish equilibrium conditions within the bottle, (c) closure leakage and (d) permeation loss, i.e. the permeation of carbon dioxid through the wall of the bottle to atmosphere. Carbon dioxide loss due to cr ep tends to be small and to substantially cease altogether after the first two to three days after carbonation

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whilst carbon dioxide losses due to closure leakage tend to be so small that for practical purposes they can ignored. The loss of carbon dioxide due to sorption tends to be more significant whilst the permeation loss is the most significant of all. The required shelf life can be attained with injection blow moulded PET bottles of larger size containing one litre or more of carbonated drink. However, with smaller size bottles, e.g., containing 250 millilitre or less of carbonated drink, the shelf life becomes unacceptably low because of the larger ratio of surface area to volume of the bottle. It is possible to reduce the permeation loss of injection blow moulded PET bottles by applying a suitable coating to the bottle, e.g., a coating of poly(vinylidene chloride). However, the application of such a coating requires that the bottle first be thoroughly degreased and cleaned of surface contamination such as by washing in a detergent/water solution and the bottles then dried prior to coating. This adds unacceptably to the cost of the bottles in what is a very competitive market. Shelf life can also be increased by increasing the wall thickness of the bottle but this is not desirable because of the high cost of PET polymer.

Other products, such as wines, beers and certain foodstuffs, are subject to biochemical changes due, among other things, to oxidation. For such products it is necessary to reduce as much as possible the ingress of oxygen into the bottle.

The present invention provides an injection blow moulded plastics bottle having a label on the outer surface thereof comprising a gas barrier for reducing or preventing the permeation of gases through that part of the wall of the bottle cover d by the label.

The invention also provides a method of reducing the permeation of gases through the wall of an injection blow

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moulded plastics bottle, the method comprising applying to the external surface of the bottle a label comprising a gas barrier.

Preferably the bottle is formed from PET polymer, although the invention is equally applicable to bottles formed from other suitable plastics materials.

Said gas barrier may be such as to reduce or prevent the egress of carbon dioxide from the bottle or the ingress of oxygen into the bottle by permeation through that part of the bottle wall covered by the label.

Said gas barrier is preferably a layer of metal or other gas impermeable material. Thus, said layer may comprise a malleable aluminium or other metal foil, e.g., having a thickness up to 0.003 inch (0.076mm) and preferably up to 0.002 inch (0.05 mm). The label may comprise a laminate having a gas impermeable layer as aforesaid and at least one other layer. Said at least one other layer may be a paper layer and/or a plastics layer. For example, the label may comprise a printed outer paper layer, an intermediate layer of metal foil and an inner layer of paper or plastics material.

Said label may cover at least 50%, and preferably at least 60%, of the external surface area of the bottle. The bottle may be designed with as large an external surface as possible suitable for receiving a label, e.g., as large an external cylindrical surface as possible as compared with the bottom and neck portions of the bottle.

The label may be secured to the bottle in any suitable manner but is preferably secured to the bottle by a continuous layer of adhesive.

According to another aspect thereof the present invention provides a method of reducing sorption losses of carbon dioxide from a carbonated drink contained in an injection blow moulded plastics bottle, the method comprising filling the bottle with carbon dioxide under pressure until the material of the bottle has absorbed

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some of the carbon dioxide and subsequently filling the bottle with the carbonated drink.

The bottle may be filled with carbon dioxide under pressure during manufacture of the bottle by injection blow moulding the bottle using carbon dioxide as the blowing medium, e.g., at a pressure of about 300 to 400 psi (21 to 28 kg/cm$^2$). Alternatively, the bottle may be filled with carbon dioxide under pressure after manufacture of the bottle but prior to filling of the bottle with the carbonated drink.

Carbon dioxide under pressure may be retained in the bottle for a period of time sufficient to ensure that the material of the bottle has become partly or fully saturated with carbon dioxide or until the bottle is filled with carbonated drink.

The invention will be illustrated by reference to the accompanying specific examples, in which examples 1, 5 and 7 are according to the prior art, examples 2, 6 and 8 are according to claims 1 to 22, and examples 3, 4, 9 and 10 are according to claims 23 to 26.

## EXAMPLE 1 (Prior Art)

| | | |
|---|---|---|
| **Parameters** | | |
| bottle capacity | 185.00 mls | acceptable % loss 20.00% |
| carbonation level | 4.00 vols | |
| wt. of botle | 15.30 g | |
| density of material | 1.36 | |
| surface area | 25.00 sq in | |
| wall thickness | 14.00 mils | |
| quoted perm loss | 15.00 mls | per .001 ins thickness per 100 sq ins per day |
| closure leakage | 0.10 mls | per day |
| SHELF LIFE | 61.85 days | |
| **Calculation of allowed loss** | | |
| allowed loss | 148.00 mls | |
| **Average internal Pressure Calculation** | | |
| carbonation level | 5.35 atmos | |
| Average internal Pressure | 4.82 | |
| **Sorption calculation** | | |
| half av. int. press. | 2.41 | use this figure on graph |
| Graph figure | 4.20 | |
| sorption | 47.25 mls | |

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Creep calculation

| | |
|---|---|
| creep value | 14.80 mls |
| combined sorption and creep value | 62.05 mls |
| allowed loss less combined sorption and creep value | 85.95 mls |

calculation of permeation loss

| | |
|---|---|
| permeation loss | 1.29 mls per day |
| add closure loss | 0.10 mls per day |
| Total permeation loss | 1.39 mls per day |
| SHELF LIFE | 62 days |

## EXAMPLE 2 (with Gas Barrier Label)

Parameters

| | | |
|---|---|---|
| bottle capacity | 185.00 | mls acceptable % loss 20.00% |
| carbonation level | 4.00 | vols |
| wt of bottle | 15.30 | g |
| density of material | 1.36 | |
| label area | 12.50 | sq in |
| uncovered surface area | 12.50 | sq in |
| wall thickness | 14.00 | mils |
| quoted perm loss | 15.00 | mls per.001 ins thickness per 100sq ins per day |
| closure leakage | 0.10 | mls per day |
| SHELF LIFE | 115.39 | days |

## EXAMPLE 3 (bottle saturated with $CO_2$)

Parameters

| | | |
|---|---|---|
| bottle capacity | 185.00 | mls acceptable % loss 20.00% |
| carbonation level | 4.00 | vols |
| wt of bottle | 15.30 | g |
| density of material | 1.36 | |
| surface area | 25.00 | sq in |
| wall thickness | 14.00 | mils |
| quoted perm loss | 15.00 | mls per.001 ins thickness per 100sq ins per day |
| closure leakage | 0.10 | mls per day |
| SHELF LIFE | 95.85 | days |

Calculation of allowed loss

| | |
|---|---|
| allowed loss | 148.00 mls |

Average internal Pressure calculation

| | |
|---|---|
| Carbonation level | 5.35 atmos |
| Average internal Pressure | 4.82 |

Sorption calculation - assume total precharge with $CO_2$

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| | | |
|---|---|---|
| half av int press | 2.41 | use this figure on graph |
| Graph figure | 4.20 | |
| sorption | 0.00 mls | |

Creep calculation

| | | |
|---|---|---|
| creep value | 14.80 mls | |
| combined sorption and creep value | | 14.80 mls |

| | |
|---|---|
| allowed loss less combined sorption and creep value | 133.2 mls |

calculation of permeation loss

| | |
|---|---|
| permeation loss | 1.29 mls per day |
| add closure loss | 0.10 mls per day |
| Total permeation loss | 1.30 mls per day |
| Shelf life | 96 days |

EXAMPLE 4 (gas barrier label and $CO_2$ saturation)

Parameters

| | | |
|---|---|---|
| bottle capacity | 185.00 mls | acceptable % loss 20.00% |
| carbonation level | 4.00 vols | |
| wt of bottle | 15.30 g | |
| density of material | 1.36 | |
| label area | 12.50 sq in | |
| uncovered surface area | 12.50 sq in | |
| wall thickness | 14.00 mils | |
| quoted perm loss | 15.00 mls per.001 ins thickness per 100sq ins per day | |
| closure leakage | 0.10 mls per day | |
| SHELF LIFE | 178.82 days | |

EXAMPLE 5 (prior art)

Parameters

| | | |
|---|---|---|
| bottle capacity | 185.00 mls | acceptable % loss 15.00% |
| carbonation level | 4.00 vols | |
| wt of bottle | 15.30 g | |
| density of material | 1.36 | |
| surface area | 25.00 sq in | |
| wall thickness | 14.00 mils | |
| quoted perm loss | 15.00 mls per.001 ins thickness per 100sq ins per day | |
| closure leakage | 0.10 mls per day | |
| SHELF LIFE | 34.34 days | |

EXAMPLE 6 (with gas barrier label)

Parameters

| | | |
|---|---|---|
| bottle capacity | 185.00 mls | acceptable % loss 15.00% |
| carbonation level | 4.00 vols | |
| wt of bottle | 15.30 g | |

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| | | |
|---|---|---|
| density of material | 1.36 | |
| label area | 17.00 | sq in |
| uncovered surface area | 8.00 | sq in |
| wall thickness | 14.00 | mils |
| quoted perm loss | 15.00 | mls per.001 ins thickness per 100sq ins per day |
| closure leakage | 0.10 | mls per day |
| SHELF LIFE | 93.38 | days |

EXAMPLE 7 (prior art)

Parameters

| | | |
|---|---|---|
| bottle capacity | 2000.00 | mls acceptable % loss 15.00% |
| carbonation level | 4.00 | vols |
| wt of bottle | 62.00 | g |
| density of material | 1.36 | |
| surface area | 140.00 | sq in |
| wall thickness | 14.00 | mils |
| quoted perm loss | 15.00 | mls per.001 ins thickness per 100sq ins per day |
| closure leakage | 0.10 | mls per day |
| SHELF LIFE | 112.79 | days |

Calculation of allowed loss

| | | |
|---|---|---|
| allowed loss | 1200.00 | mls |

Average internal Pressure calculation

| | | |
|---|---|---|
| carbonation level | 5.35 | atmos |
| Average internal Pressure | 4.95 | |

Sorption calculation

| | | |
|---|---|---|
| half av int press | 2.47 | use this figure on graph |
| Graph figure | 4.20 | |
| Sorption | 191.47 | mls |

Creep calculation

| | | |
|---|---|---|
| creep value | 160.00 | mls |
| combined sorption and creep value | 351.47 | mls |

| | | |
|---|---|---|
| allowed loss less combined sorption and creep value | 848.53 | mls |

calculation of permeation loss

| | | |
|---|---|---|
| permeation loss | 7.42 | mls per day |
| add closure loss | 0.10 | mls per day |
| Total permeation loss | 7.52 | mls per day |
| SHELF LIFE | 113 | days |

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## EXAMPLE 8 (with gas barrier label)

| Parameters | | |
|---|---|---|
| bottle capacity | 2000.00 mls | acceptable % loss 15.00% |
| carbonation level | 4.00 vols | |
| wt of bottle | 62.00 g | |
| density of material | 1.36 | |
| label area | 70.00 sq in | |
| uncovered surface area | 70.00 sq in | |
| wall thickness | 14.00 mils | |
| quoted perm loss | 15.00 mls | per.001 ins thickness per 100sq ins per day |
| closure leakage | 0.10 mls | per day |
| SHELF LIFE | 222.62 days | |

## EXAMPLE 9 (bottle saturated with $CO_2$)

| Parameters | | |
|---|---|---|
| bottle capacity | 2000.00 mls | acceptable % loss 15.00% |
| carbonation level | 4.00 vols | |
| wt of bottle | 62.00 g | |
| density of material | 1.36 | |
| surface area | 140.00 sq in | |
| wall thickness | 14.00 mils | |
| quoted perm loss | 15.00 mls | per.001 ins thickness per 100sq ins per day |
| closure leakage | 0.10 mls | per day |
| SHELF LIFE | 138.24 days | |

| Calculation of allowed loss | |
|---|---|
| allowed loss | 1200.00 mls |

| Average internal Pressure calculation | |
|---|---|
| carbonation level | 5.35 atmos |
| Average internal Pressure | 4.95 |

| Sorption calculation | | |
|---|---|---|
| half av int press | 2.47 | use this figure on graph |
| Graph figure | 4.20 | |
| Sorption | 0.00 mls | |

| Creep calculation | | |
|---|---|---|
| creep value | 160.00 mls | |
| combined sorption and creep value | | 160.00 mls |
| allowed loss less combined sorption and creep value | 1040.00 mls | |

| calculation of permeation loss | |
|---|---|
| permeation loss | 7.42 mls per day |
| add closure loss | 0.10 mls per day |
| Total permeation loss | 7.52 mls per day |
| SHELF LIFE | 138 days |

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EXAMPLE 10 (Gas barrier label and $CO_2$ saturation)

| Parameters | | |
|---|---|---|
| bottle capacity | 2000.00 mls | acceptable % loss 15.00% |
| carbonation level | 4.00 vols | |
| wt of bottle | 62.00 g | |
| density of material | 1.36 | |
| label area | 70.00 sq in | |
| uncovered surface area | 70.00 sq in | |
| wall thickness | 14.00 mils | |
| quoted perm loss | 15.00 mls per.001 ins thickness per 100sq ins per day | |
| closure leakage | 0.10 mls per day | |
| SHELF LIFE | 272.85 days | |

It will be clearly seen from the examples that the provision of a gas barrier label acording to the present invention significantly increases the shelf life of a carbonated drink contained in an injection blow moulded PET bottle, as does saturating the material of the bottle with carbon dioxide. The combination of both a gas barrier label and saturation of the material of the bottle with carbon dioxide gives even better results.

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CLAIMS

1. An injection blow moulded plastics bottle having a label on the outer surface thereof comprising a gas barrier for reducing or preventing the permeation of gasses through that part of the wall of the bottle covered by the label.

2. A bottle according to claim 1 when formed from PET.

3. A bottle according to claim 1 or 2, wherein said gas barrier is such as to reduce or prevent the egress of carbon dioxide or the ingress of oxygen by permeation through that part of the bottle wall covered by the label.

4. A bottle according to claim 1, 2 or 3, wherein said gas barrier is a layer of metal or other gas impermeable material.

5. A bottle according to claim 4, wherein said layer comprises a malleable aluminium or other metal foil.

6. A bottle according to claim 5, wherein said foil has a thickness of 0.002 to 0.003 inch (0.05 to 0.076 mm).

7. A bottle according to claim 4, 5 or 6, wherein said label comprises a laminate having a gas impermeable layer and at least one other layer.

8. A bottle according to claim 7, wherein said at least one other layer is a paper layer and/or a plastics layer.

9. A bottle according to any one of the preceding claims, wherein said label covers at least 50% of the external surface area of the bottle.

10. A bottle according to claim , wherein said label covers at least 60% of the external surface area of the bottle.

11. A bottle according to any one of the preceding claims, wherein said label is secured to the bottle by a continuous layer of adhesive.

12. A method of reducing the permeation of gasses through the wall of an injection blow moulded plastics bottle, the method comprising applying to the external

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surface of the bottle a label comprising a gas barrier.

13. A method acording to claim 12, wherein the bottle is formed from PET.

14. A method according to claim 12, wherein said gas barrier is such as to reduce or prevent the egress of carbon dioxide or the ingress of oxygen by permeation through that part of the bottle wall covered by the label.

15. A method according to claim 12, wherein said gas barrier is a layer of metal or other gas impermeable material.

16. A method according to claim 15, wherein said layer comprises a malleable aluminium or other metal foil.

17. A method according to claim 16, wherein said foil has a thickness of 0.002 to 0.003 inch (0.05 to 0.076 mm).

18. A method according to any one of claims 15, 16 or 17, wherein said label comprises a laminate having a gas impermeable layer and at least one other layer.

19. A method according to claim 18, wherein said at least one other layer is a paper layer and/or a plastics layer.

20. A method according to any one of claims 12 to 19, wherein said label covers at least 50% of the external surface area of the bottle.

21. A method according to claim 20, wherein said label covers at least 60% of the external surface area of the bottle.

22. A method according to any one of claims 12 to 21, wherein said label is secured to the bottle by a continuous layer of adhesive.

23. A method of reducing sorption losses of carbon dioxide from a carbonated drink contained in an injection blow moulded plastics bottle, th method comprising filling the bottle with carbon dioxide under pressure until the material of the bottle has absorbed some of the

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carbon dioxide and subsequently filling the bottle with the carbonated drink.

24. A method according to claim 23, wherein the bottle is filled with carbon dioxide under pressure during manufacture of the bottle, by injection blow moulding the bottle using carbon dioxide as the blowing medium.

25. A method according to claim 23, wherein the bottle is filled with carbon dioxide under pressure after manufacture of the bottle but prior to filling of the bottle with carbonated drink.

26. A method according to claim 23, 24, 25, wherein the bottle is a bottle according to any one of claims 1 to 11.

27. An injection blow moulded plastics bottle substantially as herein described.

28. A method of reducing the permeation of gasses through the wall of an injection blow moulded plastics bottle, substantially as herein described.

29. A method of reducing sorption losses of carbon dioxide from a carbonated drink contained in an injection blow moulded plastics bottle, substantially as herein described

30. A plastics bottle when produced by the method of claim 24.

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